



**Title of Investigation:**

Automated Absorber Attachment for X-ray Microcalorimeter Arrays

**Principal Investigator:**

Caroline Kilbourne (Code 662)

**Other In-house Members of Team:**

Christine Allen (Code 553), Richard Kelley (Code 662), Regis Brekosky (Code 662), and Timothy Miller (Code 553)

**Other External Collaborators:**

Eric Schulte (Private Consultant)

**Initiation Year:**

FY 2005

**Aggregate Amount of Funding Authorized in FY 2004 and Earlier Years:**

\$0

**Funding Authorized for FY 2005:**

\$50,000

**Actual or Expected Expenditure of FY 2005 Funding:**

In-house, \$50,000

**Status of Investigation at End of FY 2005:**

To be continued with \$45,000 in additional FY 2006 DDF funding for Principal Investigator Christine Allen.

**Expected Completion Date:**

September 2006

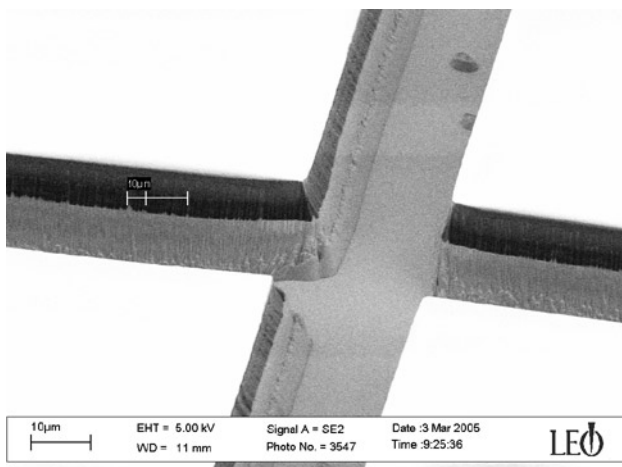
DDF annual report

### Purpose of Investigation:

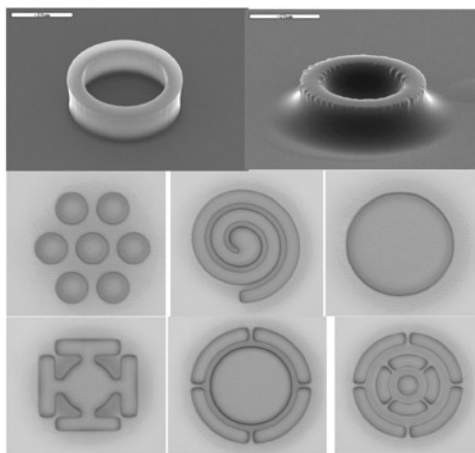
The purpose of this investigation is to develop an automated method to place X-ray absorbers on large-format X-ray microcalorimeter arrays. An X-ray calorimeter measures the energy of incident X-rays. This method will replace the arduous and risky method of manually attaching the X-ray absorbers—a technique used to build the 32-pixel arrays on the XRS/Astro-E2 and XQC satellites. The need grows for microcalorimeter arrays with hundreds of pixels. Therefore, demonstrating this capability will clearly place Goddard in a position to provide the detector assemblies for future missions, including NeXT, Constellation-X, and Gen-X.

### Accomplishments to Date:

During FY 2005, we accomplished two major goals. First, we demonstrated a technique that can lead to very good yield of high-quality, mercury-telluride absorber tiles. The method we used is deep-reactive ion etching, similar in most respects to one of the fabrication techniques now in use for making the actual microcalorimeter arrays. With this method, deep trenches can be cut in the material using a plasma, which is generated by an appropriate gaseous etchant. Samples of HgTe grown on CdZnTe were patterned at Goddard and then sent to Raytheon, in Goleta, CA, for plasma etching. Edward Smith, of Raytheon, Goleta, provided this service free of charge for demonstration purposes. Figure 1 shows a scanning-electron microscope (SEM) image of an etched sample of HgTe. Our second accomplishment was demonstrating the transfer of minute quantities of epoxy onto appropriately designed absorber-attachment structures. The original tube-shaped design was modified to have a greater surface area. It also was modified to provide venting for the epoxy so that it would not entrap air within an epoxy bubble. Figure 2 shows several design variations that were demonstrated.



**Figure 1.** Trench etched in HgTe using deep reactive-ion etching. The gray layer is 10 μm thick HgTe. The dark layer with a white top surface is the photoresist mask. (It appears white on top due to electron charge build up in the SEM.)



**Figure 2.** SEM images of the various SU8 epoxy pick-up structures demonstrated. The tubular structure, at top, is shown with and without epoxy applied. The lower structures were designed for greater surface area.

**Planned Future Work:**

In FY 2006, we plan to use SU8, a trademarked epoxy-based negative photoresist made by MicroChem Corporation. We then plan to study how well the epoxy joints adhere to the dummy absorber tiles. For this step, we will fabricate dummy tiles of 10  $\mu\text{m}$  thick silicon, which will represent an appropriate mass and size, but will be of much lower cost than HgTe absorbers. Our ultimate goal for the project's second year is to demonstrate a scalable, mechanical model of a 6x6 array of dummy pixels, with absorbers attached.

**Key Points Summary:**

**Project's innovative features:** Success in this proposal will provide a method for the simultaneous manipulation of hundreds of microscopic parts for the purpose of automated attachment of absorbers to large-format microcalorimeter arrays. This method could ultimately hold promise for many other applications as well, such as the attachment of mirror tiles for large-format micromirror arrays.

**Potential payoff to Goddard/NASA:** Success will position Goddard favorably to win the detector assembly for future space missions, including NeXT, Constellation-X, and Gen-X. This development also could possibly provide an alternate path for such future missions as JWST, which is developing a microshutter array for infrared astronomy. The micromirror array was de-selected in favor of microshutters, primarily due to the fact that a means of making an absolutely planar mirror surface could not be demonstrated. This method has potential to transfer optically flat mirror surfaces to an array of actuators.

**The criteria for success:** Our criterion for success is demonstrating a 6x6 mechanical model of microcalorimeters with absorbers attached.

**Technical risk factors:** The highest risk factor identified in the proposal was the ability to control the amount of epoxy transferred to the SU8 structures, which will hold the absorber tiles onto the detector. We have made good progress toward achieving a design capable of transferring appropriate amounts of epoxy.